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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER

FINK, BRIEANN R

ART UNIT

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1796

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PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/561,974	Applicant(s) REE ET AL.	
	Examiner Briann R. Fink	Art Unit 1796	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 22 December 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-13 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-13 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 22 December 2005 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date <u>12/22/05</u> . | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 1-13 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

Claim 1 claims a polymer having a structure of formula (I). The specification and claims 5 and 8 disclose that the polymer of claim 1 can be obtained through a reaction of a polyhydric alcohol, formula (II), with a cyclic monomer, one of formulae (III) to (VI), followed by the reaction with a glycidioxy or isocyanato alkoxy-based silane (p. 5, ll. 8-29). This combination of reactions would not result in the structure of formula (I), but would result in a structure of formula (I) **if** X was one of the following:

-CONH-(CH₂)₃-Si(OC₂H₅)₃, -CH₂CH(CH₃)-CH₂O(CH₂)₃-Si(CH₃)₂(OC₂H₅),
-CH₂CH(OH)-CH₂O(CH₂)₃-Si(CH₃)(OC₂H₅)₂, or
-CH₂CH(OH)-CH₂O(CH₂)₃-Si(CH₃)(OCH₃)₂.

The specification does not disclose a way that would enable one of ordinary skill in the art to make the invention as claimed in claim 1.

Case law holds that applicant's specification must be "commensurately enabling [regarding the scope of the claims]" *Ex parte Kung*, 17 USPQ2d 1545, 1547 (Bd. Pat. App. Inter. 1989) otherwise undue experimentation would be involved in determining how to practice and use applicant's invention. Although the statute itself does not use the phrase "undue experimentation", it has been interpreted to require that the claimed invention be enabled so that any person skilled in the art can make and use the invention without undue experimentation as stated in *Ex parte Forman*, 230 USPQ 546, 547 (Bd. Pat. App. Inter. 1986) and in *In re Wands*, 8 USPQ2d 1400, 1404 (Fed. Cir. 1988).

Specifically, in the *In re Wands* the Court set forth a non-exhaustive list of factors to be considered in determining whether undue experimentation would be involved in making and/or using the claimed invention. These factors include, but are not limited to: (a) the breadth of the claims; (b) the nature of the invention; (c) the state of the prior art; (d) the level of one of ordinary skill; (e) the level of predictability in the art; (f) the amount of direction provided by the inventor; (g) the existence of working examples; and (h) the quantity of experimentation needed to make the invention based on the content of the disclosure.

These factors can be applied to claim 1 as follows:

(a) the breadth of the claims

Claim 1 claims a polymer having a structure of formula (I). The instant specification discloses and claims that the polymer having the structure of formula (I) can be obtained through a reaction of a polyhydric alcohol,

formula (II), with a cyclic monomer, one of formulae (III) to (VI) followed by the reaction with a glycidioxy or isocyanato alkoxy-based silane (p. 5, ll. 8-29).

(b) the nature of the invention

The invention relates to a polymer having particular structure, which is useful as a low dielectric material for integrated circuits.

(c) the state of the prior art

Insulating materials having a low dielectric constant are known to be used in semiconductor devices. They require thermal stabilities, good mechanical properties, resistance to crack generation and propagation, low defect densities, low water uptake, chemical resistance, etc. The controlled introduction of porosity into existing low dielectric constant materials has been used to reduce the dielectric constant. This reduces the dielectric constant of the material while maintaining the desired thermal and mechanical properties (See *Hawker et al.*, US 6,107,357, Background Section). While pore forming polymers are known, the structural properties resulting from their different possible combinations are usually unpredictable without testing.

(d) the level of one of ordinary skill

One of ordinary skill in the art is a research scientist working in the polymer and/or electronic industry with a Ph.D. and at least 5 years of experience.

(e) the level of predictability

When the skilled artisan attempts to produce a polymer, the use of prior experimentation can be used as a guide for typical reaction mechanisms and resulting structures and properties; however, these cannot be used as an absolute consideration. Some properties of the films can be predictable; however, in order to reach the desired polymer, reaching the many properties and structural features is not predictable and can only be determined with testing.

(f) the amount of direction provided by the inventor

The disclosure provides no direction for a reaction between an alcohol, conducted by a ring opening polymerization of a cyclic monomer and a polyhydric alcohol, with any silane other than those having a glycidoxo/isocyanato alkyloxy-based structure. See page 5, ll. 8-23.

(g) the existence of working examples

The specification contains 2 working examples. Both working examples relate to polymers having a composition with an isocyanato alkyloxy-based structure (prior to the addition of the silsesquioxane).

(h) the quantity of experimentation

A large amount of experimentation, on the order of a number of man-years would be necessary to produce the invention. For example, if the skilled artisan wished to form a polymer falling within the structure of claim 1, he would be required to experiment with numerous reactants, catalysts,

concentrations of reagents, other possible components and even reaction environments to try to replicate the property of claim 1; therefore, the quantity of experimentation involved in order to reach a usable embodiment would be great.

Therefore, in light of the above factors, claim 1 is rejected for lacking enablement.

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 5 and 8 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 5 claims a reaction with a silane having the formula $\text{SiR}^3_k(\text{OR}^4)_{3-k}$, where k is 0-2 and R^3 and R^4 are C_{1-5} alkyl groups. A silane is a silicon atom having a valence of 4. As written in claim 5, the silane is required to have only a valence of 3.

It is unclear as to the type of silane the applicant is claiming in the invention. For example, one of ordinary skill in the art could recognize this silane as $\text{HSiR}^3_k(\text{OR}^4)_{3-k}$, or $\text{SiR}^3_k(\text{OR}^4)_{3-k}$ where k is 0-3, or a silane with a completely different fourth functional group such as an epoxy functionalized silane, which

are all referred to in the instant specification. Therefore, claim 5 is indefinite for failing to particularly point out and distinctly claim the invention.

Claim 1 claims a polymer with the structure of formula (I).

Claim 8 claims forming the polymer of claim 1 by a reaction between an alcohol, produced by the ring opening polymerization reaction of a polyhydric alcohol and a cyclic monomer, and an epoxy functionalized silane,

This reaction would result in a C-Si bond, which is not permitted by the structure of claim 1 which only allows for an O-Si bond or N-Si bond. It appears that the only way to obtain the O-Si bond of the instant invention is to react an alcohol with a silane such as those listed in instant claim 11.

It is not clear as to which reaction the applicants regard as the invention. One of ordinary skill in the art could interpret the invention to be the reaction between a polyhydric alcohol, a cyclic monomer and a silane, or the reaction between a polyhydric alcohol and an epoxy functionalized silane. Therefore, claim 8 is indefinite for failing to particularly point out and distinctly claim the invention. Claim 8 is also indefinite for the reason listed above for instant claim 5.

The instant specification, page 5, ll. 18-23, also discloses that the reaction between an alcohol and an epoxy functionalized silane results in the polymer of formula (I), which is not possible, again as noted above.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. 1-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Hawker et al.* (US 6,107,357), in view of *Hawker et al.* (US 6,114,458).

Patent '357 teaches a process for preparing a porous material having a low dielectric constant that is chemically and thermally stable (col. 5, ll. 53-59). It involves mixing the following:

- (i) a thermally labile porogen having a reactive site that enables covalent attachment to another molecular entity,
- (ii) a thermally stable, low dielectric constant host polymer, and
- (iii) a coupling agent to covalently bind both the reactive site of the porogen and the host polymer. (col. 5, l. 63 - col. 6, l. 2).

The porogen is taught as a thermally degradable polymer, which can be linear or branched and are preferably polyethers (col. 7, l. 59 and col. 8, ll. 1-6). The porogen must be functionalized with at least one group that is capable of being reacted with the coupling agent (col. 8, l. 22-24). The porogen may be functionalized with a reactive site comprising -OH, -NH₂, etc (col. 8, ll. 29-31). Reactive sites may be introduced by ring opening polymerization techniques to acquire hydroxyl-terminated porogens (col. 8, ll. 37-59). (Note the similarities

between the porogen of Patent '357 and the base polymer of the instant invention.)

The host polymer is taught as typically being a silicon-containing polymer, preferably being an organic polysilica of methyl silsesquioxane (col. 6, ll. 21-25 and ll. 38-43). (Note the similarities between the host polymer of Patent '357 and the silicate polymer of the instant invention.)

The coupling agent, R^1-L-R^2 , which links the porogen and the host polymer, is a compound having a functional group that is capable of covalently binding to the porogen (R^1), a functional group that is capable of covalently binding to the host polymer (R^2), connected by a hydrocarbylene linker of one of an alkylene, an arylene, and an alkyl ether (col. 9, ll. 7-19 and ll. 65-67). R^1 may be an isocyanate, a ketene, cyano, imino ether, aldehyde, ketone, etc. (col. 9, ll. 23-25). For host polymers containing free OH or COOH groups, such as terminal Si-OH in silsesquioxanes, R^2 has the structural formula $-SiX_3$, where at least one X is a leaving group (col. 9, ll. 30-41). The leaving groups are those that are hydrolysable to form a silanol linkage with the hydroxyl group of the host polymer (col. 9, ll. 41-43). Some examples of R^2 are the following: trichlorosilyl, trimethoxysilyl, triethoxysilyl, (when all 3 X groups are leaving groups), methyldimethoxysilyl, ethyldiethoxysilyl (when 2 X groups are leaving groups, the third is a lower alkyl), etc. (col. 9, ll. 46-50).

Although Patent '357 generally teaches the types of possible porogen polymers that can be used in the invention, such as polyethers, the method of forming these polymers is not taught.

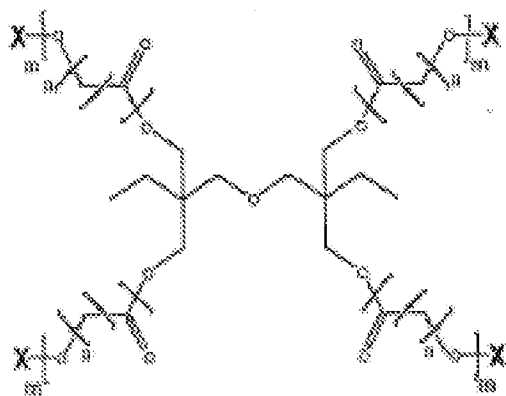
Patent '458 teaches hyperbranched polyesters as multifunctional initiator cores for the synthesis of hybrid star copolymers (col. 2, ll. 3-6). The copolymers are radially branched and are produced by the reaction of a macromolecular initiator and chain extending monomers (col. 2, ll. 8-11).

The macromolecular initiator has a high degree of reactive functionality such as hydroxyl, amine, thiol, etc that initiates ring opening polymerization (col. 2, ll. 50-53). Patent '458 does not explicitly teach possible macromolecular initiators; however, does claim some specific examples consisting of ditrimethylolpropane, ditrimethylolethane, and dipentaerythritol (col. 12, claim 10).

The chain extending monomers function to lengthen the arms of the macromolecular initiator and include some of the following: lactones, cyclic carbonates, epoxides, anhydrides, and any other cyclic monomer capable of undergoing ring opening polymerization (col. 3, l. 65 – col. 4, l. 5). The preferred chain extender has lactone functionality (col. 4, ll. 9-11).

The reaction between the macromolecular initiator and the chain extending monomer results from a ring opening polymerization adding an ether or ester functionality to the macromolecular initiator (col. 7, ll. 1-15).

The reaction between one of the macromolecular initiators specifically listed and the preferred lactone results in the following structure:



, where the macromolecular initiator is ditrimethylolpropane, the lactone is that of Patent '458, col. 4, l. 20, where R is H, m depends on the polymerization, and X is H.

Patent '458 further teaches that the copolymers have desirable mechanical and physical properties (col. 1, ll. 51-60) and can be used for forming protective coatings or as a pore generator for organic thermosets (col. 7, ll. 63-64).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have used the hyperbranched polyesters of Patent '458 as the porogens of Patent '357 because they have desirable mechanical and physical properties as well as the ability to act as a pore generator, as taught by Patent '458, as this is essential to the characteristics of the dielectric material of Patent '357.

This combination of the polyester of Patent '458 as the porogen of Patent '357 would inherently result in the structure of instant claim 1, as follows. Patent

'357 teaches in reaction of the porogen with a silane coupling agent, as above. If the silane coupling agent were reacted with the above polyester, for example, this reaction would result in the same polymer structure shown above, only now X would be represented as a silane group, as is required by instant claim 1.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have produced the polymer represented as formula (I) in instant claim 1 in view of the combination of the *Hawker* patents.

Claim 2 is satisfied when the polyester of Patent '458 is produced from ditrimethylolpropane, as shown above.

Claim 3 is satisfied as described for instant claim 1.

As to claim 5-7, Patent '458 teaches the method of producing the polyester polymer by reacting the macromolecular initiator, as described above, with a cyclic monomer, also described above, through ring opening polymerization.

Patent '458 specifically teaches the macromolecular initiator as being ditrimethylolpropane, ditrimethylolethane, and dipentaerythritol (col. 12, claim 10). Patent '458 specifically teaches the cyclic monomer as being a lactone, cyclic carbonates, epoxides, etc, preferably being that of the lactone (col. 3, l. 65 – col. 4, l. 11). The initiators and cyclic monomers of Patent '458 are the same as those required by instant claims 5-7.

Patent '357 teaches that the silane coupling agent reacts with the porogen, and has the functional groups as taught above, which meet the requirements of the silanes of instant claim 5.

Neither Patents '458 nor '357 teach the average molecular weight of the polyester copolymer/porogen; however, the reaction environment of Patent '458 (col. 8) is practically identical to that of the instant invention (p. 9).

For example, the reaction of Patent '458 used stannous 2-ethyl-hexanoate as the initiator at a temperature of 110°C for 20 hours, which was then dissolved in THF and precipitated in cold methanol. The only actual difference between the two polymerizations is that Patent '458 used a polyester derived from 2,2-bis(hydroxymethyl)propionic acid, rather than ditrimethylolpropane, and conducted the polymerization in 20 hours, rather than 24 hours. Therefore, because the reaction environments are similar, polymers produced by Patent '458 using polyhydric alcohols would inherently have the same average molecular weight as that required by the instant invention. Further, the polyester porogen with the addition of the silane would not be expected to drastically change the average molecular weight of the polymer, and it too would fall within the claimed range of instant claim 5.

As to claim 8, Patent '357 describes a variety of possible silane coupling agents, exemplifying 1-isocyanato-3-trimethoxysilyl-propane in Examples 1-3 and 5 (col. 13).

As to claim 9, Patent '357 teaches the combination of the porogen, the host polymer, and the silane coupling agent in order to produce a porous material having a low dielectric constant that is chemically and thermally stable (col. 5, ll. 53-59 and ll. 63-67). As explained above, the combination of the porogen and silane coupling agent of Patent '357 appear to be the same as the polymer of instant claim 1. The host polymer of Patent '357 is taught as an organic polysilica, again as explained above, which appears to be the same as the silicate polymer of the instant invention. Patent '357 does not specifically disclose the combination of the components as a sol-gel reaction followed by thermal decomposition; however, the method of combining the ingredients of Patent '357 involves the heating the mixture around 150-250°C (col. 10, ll. 16-19) to create a polymeric matrix comprising a discrete phase of the porogen and a continuous phase of the host polymer (col. 10, ll. 26-36). This appears to be similar to a sol-gel process, required by the instant invention. Following the production of the polymeric matrix, the composition can be spin-coated on to a substrate, which is then heated to the decomposition temperature of the porogen. As to the size of the pores formed by thermal decomposition, Patent '357 teaches that they are generally less than about 20 nm, and preferable less than 10 nm (col. 10, ll. 50-59), which would make the final dielectric material nano-porous.

As to claim 10, Patent '357 teaches the host polymer as preferably being a lower alkyl silsesquioxane, such as methylsilsesquioxane (col. 6, ll. 21-25 and ll. 38-43).

As to claim 12, Patent '357 does not teach ratio of porogen to host polymer; however, the Examples exemplify a ratio of 1:7.5, which falls within the claimed range of instant claim 12.

As to claim 13, the decomposition temperature used in Patent '357 is at least about 300°C (col. 10, ll. 37-43). There is no maximum decomposition temperature listed; however, Patent '357 teaches that the decomposition temperature to be below the glass transition temperature of the host polymer (Id.). Patent '357 further teaches that the host polymer should have a glass transition temperature of preferably at least 450°C. This maximum decomposition temperature is host polymer dependent and heating something at or above its glass transition drastically changes its properties and function. In light of this, it would be obvious that because the host polymers of Patent '357 are the same as the instant invention, one of ordinary skill in the art would expect the maximum decomposition temperature to fall below or equal to that of the maximum temperature of the range claimed in instant claim 13, because. Patent '357 does not specifically disclose whether the thermal decomposition is conducted under vacuum or under an inert atmosphere; however, this is something commonly done in the art under vacuum or inert atmospheres to reduce unwanted chemical reactions with the air.

5. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over *Hawker et al.* (US 6,107,357), in view of *Hawker et al.* (US 6,114,458), as applied to claims 1-10, and further in view of *Ferrar et al.* (US 6,517,984).

Patent '357 in view of Patent '458 renders instant claims 1-10 as obvious, as noted above. Patent '357 teaches that the organic polysilica is preferably methyl silsesquioxane, however, does not teach how the host polymer, the organic polysilica is produced.

Ferrar et al. teaches that silsesquioxanes are generally prepared by the hydrolysis and condensation of methyltrimethoxysilane (col. 4 ll. 34-35) which is the same as a "sol-gel" process. *Ferrar et al.* further teaches they produce a hard coat (col. 4, ll. 41-42).

Therefore, it would have obvious to one of ordinary skill in the art at the time the invention was made to have used the hyperbranched polyesters of Patent '458 as the porogens of Patent '357 because they have desirable mechanical and physical properties as well as the ability to act as a pore generator, and to produce the host polymer of Patent '357 by a sol-gel process using methyltrimethoxysilane because it produces a hard coating, which would prevent cracking when used in the invention of Patent '458.

Conclusion

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.
 - i. *Kang et al.* (US 2006/0127587) discloses a composition for forming a porous , low dielectric insulating film of an organosilicate polymer formed through a sol-gel process, but does not use disclose the method of making the core polymer (labeled as L).

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- ii. *Ree et al.* (US 7,479,509) discloses the same invention as the current application; however, is not eligible as prior art. Note that although the claims written as of November 17, 2005 are not currently subject to a double patenting rejection, when amending the claims to overcome the above rejections under the first and second paragraphs of 35 U.S.C. 112, applicants should consider a possible double patenting situation.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Briann R. Fink whose telephone number is (571)270-7344. The examiner can normally be reached on Monday through Friday, 7:00 AM to 4:30 PM (EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Randy P. Gulakowski can be reached on (571)272-1302. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/B. R. F./
Examiner, Art Unit 1796

/Randy Gulakowski/
Supervisory Patent Examiner, Art Unit 1796